Faculty of Resource Science and Technology

COMPARISON OF HERPETOFAUNAL SPECIES DIVERSITY BETWEEN ADJACENT LIMESTONE AND SANDSTONE HABITATS AT GUNUNG PENRISSEN, PADAWAN, SARAWAK (BORNEO)

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DECLARATION

I hereby declare that this thesis is based on my original work except for the quotations and citations which have been acknowledged. I also declared that it has not been previously or concurrently submitted for any other degrees at UNIMAS or any other institutions of higher learning.

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Cm	: Centimetre	10
E	: Eastern	10
GPS	: Global Positioning System	10
Km	: Kilometre	10
N	: North	10
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ABSTRACT

A study on comparison of herpetofaunal species diversity between adjacent limestone and sandstone habitat at Gunung Penrissen, Padawan, Sarawak (Borneo) was conducted. Sampling took place over a period of 12 days-17 January, 2012 to 23 January, 2012 for limestone habitat and on 9 February, 2012 to 14 February, 2012 for sandstone habitat. Besides two hours time constrained method, there were eight pitfalls traps and six glue traps were set at each sites. A total of 109 individuals, representing nine families comprising 18 genus and 21 species were recorded. Of these, 58 individuals were from limestone habitat comprising six families and 10 species. The most abundant species on that limestone habitat was *Philautus tectus* with 18 individuals were recorded. A total of 51 individuals were from sandstone habitat, comprising nine genus and 16 species. The most abundant species at the sandstone habitat was *Leptobrachella mjobergi*, with 16 individuals. Using pitfall trapping, two species were recorded *Hylarana picturata* and *Cyrtodactylus consobrinus* and two species recorded using glue traps, *Eutropis rudis* and *Cyrtodactylus consobrinus*. Individuals caught using traps were recorded only on the limestone habitat. Analysis used in this study are DIVERS, Zar *t*-test, EstimateS, and chi-square test and results from the analysis showed that the sandstone habitat is more diverse than limestone habitat.

Keywords: Herpetofauna, sandstone, limestone, species diversity, DIVERS, EstimateS.

ABSTRAK

Suatu kajian ke atas perbandingan kepelbagaian species herpetofauna di antara batu kapur bersebelahan dengan habitat batu pasir di Gunung Penrissen, Sarawak (Borneo) telah dijalankan. Kajian telah dijalankan pada 12 hari, 17 Januari, 2012 hingga 23 Januari, 2012 di habitat batu kapur dan daripada 9 Februari, 2012 hingga 14 Februari, 2012 di batu pasir. Selain dari dua jam masa kajian yang ditetapkan, lapan perangkap pitfall dan enam perangkap gam telah diletakkan di setiap habitat. Sebanyak 109 individu yang mewakili sembilan keluarga yang terdiri daripada 18 genus dan 21 species. Daripada jumlah tersebut, 58 individu dari habitat batu kapur terdiri daripada enam keluarga dan 10 spesies. Spesies yang paling banyak di habitat batu kapur adalah Philautus tectus dengan 18 individu telah direkodkan. Sebanyak 51 individu adalah dari habitat batu pasir yang terdiri daripada sembilan genus dan 16 spesies. Spesies yang paling banyak di habitat batu pasir adalah Leptobrachella mjobergi dengan 16 individu. Menggunakan perangkap pitfall, dua spesies telah direkodkan iaitu Hylarana picturata dan Cyrtodactylus consobrinus. Semua individu yang terperangkap hanya direkodkan di habitat batu kapur. Analisa yang telah digunakan di dalam kajian ini adalah DIVERS, Zar t-test, EstimateS, dan chi-square test dan keputusan daripada analisa menunjukkan bahawa spesies di habitat batu pasir adalah lebih pelbagai dari habitat batu kapur.

Kata kunci: Herpetofauna, batu pasir, batu kapur, kepelbagaian spesies, DIVERS, EstimateS.

1.0 INTRODUCTION

1.1 Limestone and sandstone forests

Malaysia is rich in limestone and sandstone forests, one of the locations being at the base of Gunung Penrissen near Padawan, Sarawak (Borneo). The 1,329 m Gunung Penrissen dominates western Sarawak, and forms the boundary between Malaysia's Sarawak state and Indonesia's Kalimantan Barat Province, and is drained mainly by Sungei Semadang and the headwaters of the Batang Kayan. Wilford and Kho (1965) reported that the Pedawan formation consists of a thick sequence of moderately to steeply dipping marine shale, mudstone, and sandstone, with beds of conglomerate, limestone, and radiolarite. It also includes a few andesite, dacite, and rhyolite lavas and associated tuffs.

Limestone forest is made up of the shells of minute marine organisms that lived millions years ago. Limestone and sandstone can be identified according to their colouration, the elements that made up the environment and also the environment itself. The Padawan limestone is among the oldest rocks in Sarawak (Mohammad *et al*., 2008). Limestone form sedimentary rocks which are composed of minerals such as calcite and aragonite, and different from the crystal forms of calcium carbonate ($CaCO_3$).

According to Vermeulen and Whitten (1999), the biodiversity of limestone ecosystem comprises species able to adapt with highly alkaline environment due to abundance of calcium carbonate, species that can live in a exceeding dry soil conditions and species confined to or found primarily in limestone caves. In other words, limestone forests absorb surface water as it is a loose ground and will be move towards karsts, this will eventually make the environment more alkaline and therefore, flora tends to be shorter and the fauna present will be minimized to specific species (Vermeulen & Whitten, 1999).

On the other hand, sandstone, or also known as arenite, is a sedimentary rock and have been formed from rock grains and sand. It is composed from either quartz or feldspar or both because these are the most common minerals on Earth. Lithified carbonate sands would be termed limestone and not sandstones (Pettijohn *et al.*, 1987). Sandstone has more surface water sources as it is not as porous as limestone.

1.2 Herpetofaunas

Herpetofaunas consist of amphibians and reptiles. It is a diverse class of vertebrates, especially in the tropics. Amphibians are tetrapods (Gr. Tetra, four + podos, foot). The name is derived from the presence of four muscular limbs and feet with toes and fingers or digits (Miller & Harley, 2007). Anurans can be divided into three orders, Caudata (Urodela), Gymnophiona (Apoda) and Anura (Salientia). Member of order Caudate are salamanders. Throughout their live, they posses tail and both pair legs are relatively unspecialized. Ideal environment for the salamander is at the moist place. Most of the members from this order have an internal reproduction.

Order Gymnophiona comprises caecilians. According to Miller and Harley (2007), caecilians are worm-like burrower and have a segmented body structure and they survive with the consumption of worms and other invertebrates in the soil. The reproduction for this order's members is the internal reproduction. Inger and Stuebing (2005), stated that the order Anura is commonly known as frogs and toads. Anurans usually live in moist environment. Miller and Harley (2007), stated that adult anurans have a reduced tail and caudal vertebrae fuse into urostyle along with the long and muscular hind limbs and also webbed feet. There are six families for this order Megophyridae, Bufonidae, Microhylidae, Ranidae, Rhacophoridae and Bombinatoridae.

Reptiles have a unique features which is the amniotic eggs, rib ventilation of the lungs and thicker, and more waterproofed skin. There are four orders Testudines, Squamata, Sphenodonta and Crocodilia. Testudines are enclosed in shells consisting of a dorsal carapace and a ventral plastron. This shell helps to protect the members. Order Squamata has two suborders which are suborder Sauria and Serpentes. Suborder Sauria is a lizard. Lizards are an extremely diverse group, comprising terrestrial, burrowing, aquatic, arboreal, and aerial members. The suborder Serpentes includes snakes which are limbless and usually lack pectoral and pelvic girdles except in pythons, boas, and some other snakes (Hickman *et al*., 2009).

1.3 Objectives

The objectives of this study are:

- To determine the species richness of herpetofauna in limestone and sandstone habitats at Gunung Penrissen, Padawan, Sarawak.
- To compare the species relative abundance of herpetofauna in limestone and sandstone habitats at Gunung Penrissen, Padawan, Sarawak.

1.4 Problem Statements

There is a need to study species richness of the herpetofaunas. In addition, there are insufficient data on the herpetofauna of Gunung Penrissen, Padawan, Sarawak. These habitats differ in terms of their physical, chemical, and biological characteristics. Limestone and sandstone forests elsewhere may show distinct flora and fauna, as many ecosystems may be supported in such substrate types.

1.5 Hypotheses

Question 1:

H_O: There are no significant differences in species diversity of herpetofauna at adjacent limestone and sandstone forests at Gunung Penrissen, Padawan, Sarawak (Borneo).

H_A: There are significant differences in species diversity of herpetofauna at adjacent limestone and sandstone at Gunung Penrissen, Padawan, Sarawak (Borneo).

Question 2:

H_O: There are no significant differences in species richness of herpetofauna at adjacent limestone and sandstone forests at Gunung Penrissen, Padawan, Sarawak (Borneo).

H_A: There are significant differences in species richness of herpetofauna at adjacent limestone and sandstone at Gunung Penrissen, Padawan, Sarawak (Borneo).

2.0 LITERATURE REVIEW

2.1 Previous studies

Many studies that related to the diversity of herpetofaunas had been conducted. There was a study of diversity of anuran amphibians at Trus Madi, Sabah, Borneo. This study was conducted by Hee (2001). Trus Madi consists of sub-montane and montane forest. There were three sites that had used during this study. A total of 33 individuals from 11 species of anurans from seven genera and five families were sampled throughout the sampling period of six days. Seven out of 11 species found are endemic species of Borneo.

A study by Ramlah *et al.* (2002) on the amphibians at Crocker Range National Park, Sabah, showed total of 110 individuals and 18 species comprising five families were recorded which are family of Ranidae, Bufonidae, Microhylidae, Megophrydae and Rhacophoridae. Individuals from family Ranidae dominated the area with 65 individuals. There are two sites chosen which are Site A near Park headquarters and Site B on the way to Keningau and Mahua waterfall. There were no significant differences in terms of species occurrence for the two sub-sites. Site A captured a larger amount of amphibians but Site B is more diverse than Site A in terms of species captured.

A study was conducted by Naming and Das (2004), on the herpetofauna in Sarawak Bau limestone biodiversity. The study sites covered mostly low-lying areas and sandstone and granite mountains. Field surveys spanned from September 2001 until June 2003 with the help of 126 persons. A total of 34 species of anuran amphibians belonging to 20 genera were collected. There were 33 new records for the region itself. In addition to this, there a collection of tadpoles of one species *Leptobrachium abbotti*. Besides that, there were a total of 33 species of reptiles belonging to 27 genera.

According to Clements *et al.* (2006), limestone karsts are overexploited, despite having a great level of endemism. This eventually lead to population declines and species extinction. Avifauna at Padawan Limestone Area, Sarawak shows high diversity. The study was conducted for seven days at each of two study site, at Giam and Danu. Study also compared species richness and relative abundance of bird species richness and abundance of bird species in other limestone areas (Mohammad *et al.*, 2008).

A study was conducted to estimate snake species richness of the sandstone Santubong Peninsula (Borneo) in two different ways (van Rooijen, 2009). Three sampling methods were applied in this study. 175 specimens from 32 species were sampled in 98 search days. The species caught consist of 14 species nocturnal and 18 species diurnal species. Adequate sampling coverage through both space and time is thus required to avoid underestimation of species richness.

Another study was conducted to compare amphibian communities through time and from different places in Borneo forests by Inger and Voris (2009).These sampled along 18 streams at eight localities in Borneo. There were 49 species found and total sample size was 13,249. There were an overlaps between the streams at a locality were there were generally higher than overlaps of pairs of streams from different localities.

There were previous discoveries at Gunung Penrissen, Padawan, Sarawak and other localities in Malaysia which consist of the limestone forest or sandstone forest (Struebig *et al.*, 2006). Pui *et al.* (2011) reported the rediscovery of *Ansonia latidisca*, the Bornean Rainbow Toad, on Gunung Penrissen, Western Sarawak, Borneo. According to these authors, Gunung Penrissen comprises of karsts features and also sandstone. The study was about to discover populations of *Ansonia latidisca,* employing standard inventory techniques appropriate for forest-dwelling bufonids (Pui *et al.*, 2011). This showed that

Gunung Penrissen has high species richness and offering many suitable habitats for the amphibians.

A study conducted by Ibrahim *et al.* (2012) on the biodiversity of frogs and toads from Compartment 15 of Gunung Inas Forest Reserve, Kedah. This study was carried out for six months sampling period. According to Ibrahim *et al.* (2012), 28 species of anurans from six families were recorded and the most abundant species were *Amolops larutensis* and *Phrynoidis aspera*. The result of the Shannon-Weiner Diversity Index (H') was 0.745 and the Evenness Index (J) was 0.149. The undisturbed environment is one of the factor which the anurans can be found abundantly.

3.0 MATERIALS AND METHODS

3.1 Study sites

This study was conducted at limestone and sandstone forests on the foothill of Gunung Penrissen, Padawan. Gunung Penrissen summit as a GPS reading of latitude 1° 08' N and longitude of 110° 13' E, with altitude of 1,326 m. These two sites were used to determine and compare the diversity of herpetofaunal species. The limestone area of Kampung Danu (Site A) and the sandstone area at Kampung Annah Rais (Site B), these location are less than 15.16 km away from each other.

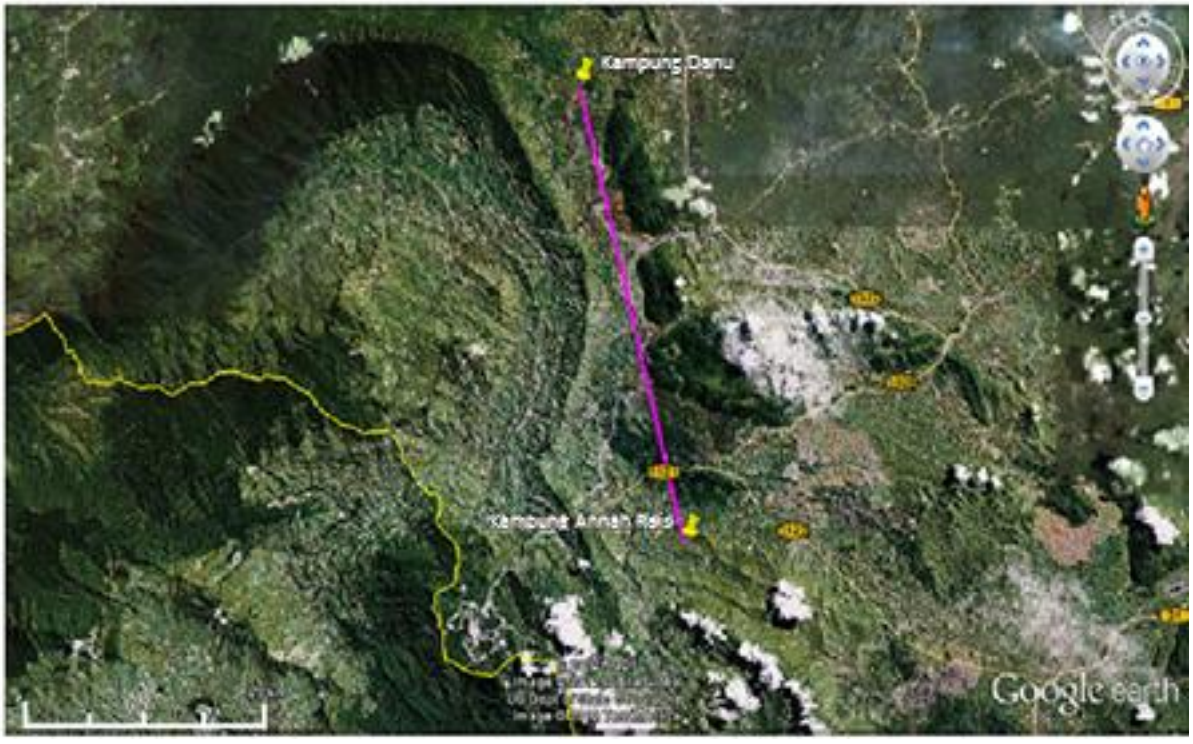

Figure 1: Location of sampling sites, Kampung Danu and Kampung Annah Rais. Source: Google Earth (1 cm : 8.23 km).

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3.2 Field techniques

Three sampling methods have been used to collect data from the field. These are time constrained sampling methods, pitfall traps and glue traps. The time allocated for time constrained sampling method was kept constant. The traps that were used were in equal numbers at both sites. Time constrained method is a technique that requires transect with a restricted or allocated time. The time constrained sampling method was done for two hours. All amphibians and reptiles caught or observed were recorded. After the time constrained transect was finished, any further amphibians or reptiles observed were not recorded. During the sampling method period, there are several variables had been recorded. The variables were distance from the nearest tree (m), diameter of the nearest tree (m), canopy cover (%), and distance from the leaf litter (cm). These variables are similar to those variables for line transect.

The second sampling method was the pitfall trapping. Pitfall traps are used to sample reptiles such as snakes and lizards and sometime frogs. The pitfall trap was buried into the soil for about half a meter or until the trap was fully buried. Usually, lizards were caught by hands. When encountering with snakes, several safety measures were practiced such as not to tease, poke, harass or disturb them, wearing proper footwear, and use sticks to turn over the logs and rocks.

The third sampling method was the glue trapping. Using this method, the captured animals were trapped while it was moving along a tree trunk. The glue was applied on a plastic bag which was tied around the tree with a string. The captured animals were released by applying oil, turpentine, onto the stuck animal. This method is effective and non-toxic to humans. According to Bennett (1999), glue traps can be placed anywhere and sometimes it can be baited. The glue traps were checked twice a day.

3.3 Processing specimens

3.3.1 Handling and Identification

Specimens were carefully handled and transferred into different plastic bags to avoid stress and injuries to them and to others. On the plastic bag, several data were recorded. Specimens were identified and measured. Body measurements for amphibians include snout-vent length (SVL) and weight (W); body measurement for reptiles includes snout-vent length (SVL), weight (W) and tail length (TL).

Captured amphibians and reptiles were released as not all individuals were preserved as voucher specimens. Releasing the amphibians and reptiles helped capture recapture methods in future. Marking techniques for amphibians followed the Martof systems (1953). Frogs and toads captured were identified using the identification keys from "A Pocket Guide: Amphibians and Reptiles of Brunei" (Das, 2004) and "A Field Guide to the Frogs of Borneo" (Inger & Stuebing, 2005). Other reptiles captured were identified using "A Field Guide to the Snakes of Borneo" (Stuebing & Inger, 1999), "A Pocket Guide: Lizards of Borneo" (Das, 2004), and "A Photographic Guide to Snakes and other Reptiles of Borneo" (Das, 2007).

3.3.2 Preservation

Several techniques are available to make good voucher specimens. In this project, amphibians and reptiles were euthanized in a way that they are not damaged and are relaxed. Herpetofaunas which are turned into voucher specimens were first euthanized using chlorobutanol. The solid form of chlorobutanol was diluted with distilled water. Each specimen were given their own field number. Tissue samples from the liver or from the leg tissues were taken for future studies. After tissue samples were removed, the specimen was immediately fixed.

Two preservation solutions were used; formalin and alcohol. The dilution formula for the solution was determined by using; $M_1V_1=M_2V_2$. The formalin was diluted until it became 4% in concentration. The container was first placed with tissue paper which are wetted with 4% formalin. The specimens were then fixed and all important features of the specimens were shown. Lizards and skins specimens were first injected with concentrated alcohol to ensure that each parts of the specimens were came into contact with the alcohol. After 24 hours, hardened specimens where transferred to 70% ethanol for long term storage.